DOCUMENT RESUME

ED 210 537 CE 030 829

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TITLE Low Energy Technology. A Unit of Instruction in Agricultural Economics. Planning for Energy Savings.
INSTITUTION Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
PUB DATE 81
NOTE 73p.; For related documents see CE 030 819-828.
AVAILABLE FROM Instructional Materials Service, University of Florida, 101 Rolfs Hall, Gainesville, FL 32611 ($3.00).

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Agribusiness; *Agricultural Education; Behavioral Objectives; *Budgeting; *Conservation Education; Course Content; Curriculum Guides; *Energy Conservation; Extension Education; *Farm Management; Fuel Consumption; High Schools; Instructional Materials; Learning Activities; Money Management; Natural Resources; Postsecondary Education; *Resource Allocation; Teaching Guides; Test Items; Transparencies
IDENTIFIERS Energy Consumption; Florida; Pest Control

ABSTRACT

This unit of instruction on farm management for energy savings was designed for use by agribusiness and natural resources teachers in Florida high schools and by agricultural extension agents as they work with adults and students. It is one of a series of 11 instructional units (see note) written to help teachers and agents to educate their students and clients about the problems of energy shortages and strategies for energy conservation and management. Suggested as supplemental curriculum material for a course on farm management, this unit is organized into four modules. Topics covered in the unit include the budgeting process; sample budgets, cultural practices for energy savings, integrating pest management; irrigation systems; and costs of equipment and fuel consumption. The unit contains student performance objectives, content information, teaching-learning activities, student handouts, transparency masters, and evaluation instruments. (KC)

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LOW ENERGY TECHNOLOGY
A UNIT OF INSTRUCTION
IN
AGRICULTURAL ECONOMICS
PLANNING FOR ENERGY SAVINGS

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Gainesville
1981

This public document was promulgated at a cost of $1421.62 or $1.80 per copy to inform the public about Low Energy Technologies for Florida.

CE 030 829

This unit of instruction was developed as a part of the Low Energy Technology Program of the Institute of Food and Agricultural Sciences, University of Florida. Additional copies of this and other units of instruction in Low Energy Technology can be obtained by contacting the Instructional Materials Service, 101 Rolfs Hall, University of Florida, Gainesville, Florida 32611.

INTRODUCTION

Profitable farm management is the result of making the right decisions at the right time. The most difficult task of any farm manager is allocating farm resources to make a reasonable profit. Energy requirements have become an important consideration in determining the total budget.

Florida farmers, with their energy-intensive methods, should be prepared for higher and higher energy costs and plan accordingly. By understanding the importance of budgeting and good management, the farmer can reduce energy requirements and at the same time, reduce production cost per acre.

This unit of instruction on Farm Management has been divided into four modules which are designed as supplemental curriculum material and should be used in conjunction with a major unit of instruction in farm management. The student performance objectives are listed for each module. Upon completion of this unit, the student will be able to:

Introduction - Module 1

1. Identify and list four cost categories that should be considered when allocating farm resources.

2. Define in writing, key terms essential in understanding the budgeting process.

Budgets - Module 2

1. Describe a budget, how they are developed, and decisions made when using budgets.

2. Complete a sample budget for a corn enterprise, making appropriate adjustments for the rising costs of petroleum-based products.

Energy Savings in Agricultural Practices - Module 3

1. List and explain at least five cultural practices that result in energy savings.

2. Give a written explanation of integrated pest management.

3. List and explain at least three irrigation practices that would save energy.

4. Compare and contrast "Drip" and "Gun" irrigation systems in terms of energy savings.

Energy Savings in Field Equipment - Module 4

1. Calculate the fuel costs for different types of tractors; given the price for fuel, tractor horse power, fuel usage rate, and hours of operation.

2. Calculate the amount of fuel lost in unnecessary idling of tractor engines.

3. Calculate the difference in fuel consumption between tractors equipped with bias tires, ply and radial ply tires.

4. Identify three reasons why fuel savings occur when using radial ply tires.

5. Determine the proper amount of front and rear ballast required for maximum fuel economy in a tractor.

6. List three fuel tips that will reduce fuel consumption in farm tractors.

7. List five engine operating tips that will reduce fuel consumption in farm tractors.

8. List five engine maintenance tips that will reduce fuel consumption in farm tractors.

This unit includes student performance objectives, content information teaching-learning activities, student handouts and references.

This unit was designed for use by Agribusiness and Natural Resources Education Instructors in Florida High Schools and by extension agents as they work with youth and adults. This unit of instruction was developed by the Department of Agricultural and Extension Education and the Institute of Food and Agricultural Sciences as part of their Low Energy Technology Program.

Special thanks to the numerous extension specialists and faculty members of the Institute of Food and Agricultural Sciences who made significant contributions to this publication by supplying the resources and data necessary for this unit.

LOW ENERGY TECHNOLOGY
AGRICULTURAL ECONOMICS: PLANNING FOR ENERGY SAVINGS

UNIT: FARM MANAGEMENT

MODULE: INTRODUCTION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. Identify and list four cost categories that should be considered when allocating farm resources.	Four Cost Categories: - Variable Costs - Field Costs - Opportunity Costs - Marginal Costs	Read Handout: Introduction to Farm Management .
2. Define in writing, key terms essential in understanding the budgeting process.	Key Terms: - Cash Costs - New-Cash Costs - Return to Management - Farm Management - Short Run - Long Run - Land - Capital - Labor - Management - Budgeting	For each cost category identified, list 10 examples of costs which fall into this category. After reading the handout Budget Terms , enter each definition into the student notebook under the unit titled Farm Management.

Variable Cost - As the name implies, a variable cost is one that varies. It varies with production. These are the costs that change directly with the level of use or output. Cash outlays such as wages, fuel, repairs, supplies, materials and electricity are variable costs. These are the expenses we are most familiar with because they are out-of-pocket expenses.

Fixed Cost - Fixed costs are cash and non-cash expenses such as some taxes, insurance, depreciation, interest on intermediate and long term debt and some salaries. We commonly call these items overhead and they usually remain constant within a given accounting period. Fixed costs are quite a bit harder to identify than variable costs and are a great deal more difficult to allocate to a given production practice, e.g. the fixed cost of pickup travel per acre of grove worked.

Opportunity Cost - This is a non-cash cost that most operators overlook. Opportunity cost or alternative cost is the amount of return, usually stated as a percentage, which is foregone by not doing the next best thing. For example, the opportunity cost of owning a tractor is the amount of return lost by not putting that "chunk of money" in some investment such as equipment, intermediate term bank notes, bonds, or any other alternative that may be pursued. Opportunity cost is really the basis of pricing all things in our economy. Why does a tractor driver demand $4.00 per hour? Because his opportunity cost or best alternative is to make $4.00 per hour driving a truck or working in a shop at Disney World. Interest on investment is a change for opportunity cost and is a fixed expense. Interest on investment for a particular item, such as a tractor, should be calculated before the machine is purchased and thus compared to other alternatives to determine if some other investment would be more profitable.

Marginal or Added Cost - Added costs are the ones that will occur in the very near future. These are the costs that would be associated with taking on an additional 20 acres of grove work. Added costs are always variable, meaning if you have the men and machinery to take on the extra work, the only costs that you would calculate are the additional man hours and the cost of fuel, oil, and repairs on machinery. Therefore, if the return from the job will be greater than the cash or variable expenses of doing it - you should take it. However, if the new job is large enough to make it necessary to hire another man or buy more machinery, then all your costs must be recalculated. If the new job means hiring another man, then the return from the new job must cover his complete salary on a full-time basis plus your regular costs. If it doesn't you had better leave it to someone else or, as many operators do, start looking for more work to justify the new expenditure. The added costs over the costs of the present operation, are the relevant costs to take into account when making a management decision to start a new enterprise or take on more work.

SUMMARY

We have discussed four cost categories:

1. Variable = the costs that are visible out-of-pocket expenses, wages, fuel, oil, etc.
2. Fixed = These are the harder to allocate costs such as depreciation, interest on investment, taxes, insurance and some fixed supervisory salaries.

3. Opportunity Cost = The amount of income or rate of return given up by not doing the best or next best thing. Interest on investment is a cost which should be charged against a particular item to account for the return lost by not putting that "chunk of money " in another profitable use.

4. Marginal or Added Cost - This is the cost associated with working that extra acre. It is a varible cost which should be covered by the return from that extra acre. As long as the added returns from a new venture are greater than the added variable costs, it will be profitable. However, don't over-estimate the capacity of your machinery and your employees or you may find that an extra 20 acres or so of work costs more than it is worth. This may happen if the new job means adding another machine or hiring another full-time employee.

BUDGET TERMS

Cash costs are incurred when inputs are purchased for production. The cost of the input is the money paid to obtain it. Cash expenditure for fuel, fertilizer, repair, etc. are cash production costs.

Non-cash costs are not as easily recognized and are more difficult to handle. They are items like unpaid family labor, interest on equity, and depreciation.

Returns to management is the dollar amount remaining from the sale of the product after all costs have been subtracted.

Farm management is the coordination and supervision of the farm process for long run maximum profits or other specified goals.

Short run is a period of time short enough so that some inputs are fixed, generally this is a production planning period.

Long run is a period of time long enough so that all inputs can vary in quantify.

Land is a natural wealth used in production. It is created without human resources. Land also includes soil, nature trees, minerals and wild animals.

Capital is wealth used in production - it differs from land in that it is man-made. Capital includes machinery, fertilizer and buildings.

Labor is the physical human energy used in production.

Management is the mental human energy used in production, and is primarily concerned with decision-making and risk-bearing. Tools that help management save time and energy are calculations and computers.

Budgeting:

- is a written plan for future action, including the qualified anticipated results.
- is a formal means for getting down the most important information influencing decisions about how a business should be organized.
- is a paper & pencil approach to planning. It helps a manager make "mistakes" on paper before he makes a costly erroneous decision.
- is to determine dollar & cents comparisons of possible future actions on ways of organizing a business.
- it is to provide useful economic information for decision making.

EVALUATION

1. List and identify four cost categories that should be considered when allocating farm resources.

2. Define the following terms:
   a. cash costs

   b. new-cash costs

   c. return to management

   d. farm management

   e. short run

   f. long run

   g. land

   h. capital

   i. labor

   j. management

   k. budgeting

LOW ENERGY TECHNOLOGY
AGRICULTURAL ECONOMICS: PLANNING FOR ENERGY SAVINGS

UNIT: FARM MANAGEMENT — MODULE: BUDGETS

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. Describe a budget, how they are developed and decisions made when using budgets.	A budget is: - A systematic listing of income and expenses. - Projected farm income. - Projected expenses. - Projected resources. Where budgets come from: - Approved production practices. - Records Decisions made from budgets: - Returns above variable cost. - Returns above total cost. - Annual credit needs. - Crops to produce. - Residual analysis.	Read Handouts: Budgets: What, How and Why? Introduction to Farm Planning.
2. Complete a sample budget for a corn crop; making appropriate adjustments for the rising costs of petroleum-based products.	Sample budget: - Description of product. - Variable costs. - Income over variable costs	After completing the reading assignments, study the sample corn budget attached. Assuming that cost of fertilizer, crop chemicals, and fuel/oil increased 50%, calculate the income over variable cost that would be returned per acre of production.

BUDGETS: WHAT, HOW AND WHY?

Budgets are a prerequisite for all farm management analyses or recommendations. Since there are so many applications of budgeting, the problem is to pare down the material to a manageable size. Therefore, this paper will outline what budgets are, what decisions can be made from them, and where the necessary information comes from.

Budgeting Highlights

A Budget Is

A Systematic Listing of Income and Expenses for a Production Period:

-- For crop and livestock enterprises
-- For all enterprises on the farm.
-- For business financing
-- For forward planning
-- For management control.

Projected Farm Income:

-- Expected yield times expected price.
-- Head of livestock times expected price.

Projected Expenses:

-- Variable costs; short-run expenses, vary with output.
-- Fixed costs; long-run expenses, do not vary with output.
-- As production progresses, variable costs become fixed.

Income - Expenses = Returns:

-- Returns above variable costs.
-- Returns above total costs.
-- Returns to unpaid resources.

Decision Making from Budgets

Returns Above Variable Costs:

-- Should a farmer produce? If he covers variable costs, but not fixed costs, he produces until equipment needs replacing, then quits.
-- Indicate which enterprise to produce in short-run.
-- Guides input use decisions among enterprises.
-- Be sure what costs have been covered. Do not compare returns above variable costs to returns above fixed and variable costs for another enterprise.

Returns Above Total Costs:

-- Indicated long-run profitability. Total costs must be covered to stay in business.
-- Indicated relative profitability among enterprises.

Annual Credit Needs:
Enterprises to Produce:
Residual Analysis:

-- Rental rates; equipment, land, allotment.
-- Value of inputs; management return, labor return.
-- Land taxes.
-- Return on investment.

Where Budgets Come From

Approved Production Practices; Research Results:

-- Useful for new farmers.
-- Determine variable costs from practices.
-- Determine fixed costs from thumb rules or machinery manufacturer's estimates.

Records:

-- Useful to existing operators.
-- Allocate variable expenses among enterprises.
-- Allocate fixed expenses among enterprises.
-- Allocate returns among enterprises.

Combination of Above:

-- Variable costs from prescribed practices.
-- Fixed costs from records.

SUMMARY

Budget uses are many, the most important use made is that of giving a producer a clear picture of what he should expect from an enterprise.

There are various tools available for choosing among alternative enterprises, but they all require good budgets for the various enterprises.

Financial needs may be determined with budgets. Lenders are impressed when loan requests are accompanied by budgets showing the basis for request. Budgets can show the effects of increase in energy costs on the return to management; can determine breakeven prices for crops, can help decide whether to buy or rent land and how much labor one can afford to hire.

A farm manager needs to develop a systematic method for gathering information, analyzing that information, then choosing among the financial alternatives available to him. This device is called a budget. Budgets enable the farm manager to efficiently make decisions regarding investments and production techniques related to his operation. Due to the increased cost of energy, budgets play a greater role in the decision process of the farm manager. A budget in itself is not a perfect tool for predicting a total yield or profit. It is only as accurate as the information used for developing the inputs. No one knows exactly how much fuel will cost for planting or housing next years crop, nor do they know what fertilizer will sell for in six months. Most farm related expenses are either directly or indirectly related to the cost of energy - particular petroleum. A farm manager must know at what price he can pay for his inputs and still make a profit.

Once the farm manager has understood the usefulness of a budget, he can use budgets to enable him to make decisons. By comparing his opportunity costs with different production systems he will be able to reduce some of the risk involved.

INTRODUCTION TO FARM PLANNING

Successful farm planning--either for the total farm business or for individual crop and livestock enterprises--involves a few basic considerations. In order to take advantage of these, the farm manager should:

(1) Become familiar with the role of a manager--the jobs he must perform.

(2) Recognize the need for farm and financial planning.

(3) Understand the nature of planning as it relates to the farm business.

(4) Learn to select and use various kinds of farm planning tools and techniques.

(5) Acquire a knowledge of basic production economic concepts and management principles.

FARM MANAGEMENT DEFINED

Farm management involves acquiring resources, organizing a system for combining these resources in a profitable manner, and putting this system into operation.

Farm operators have three main categories of resources with which to work--land, labor, and capital. Capital includes the assets used in the farm business, such as buildings, machinery, livestock, and cash or credit for operating the business. Labor often is provided entirely by the farm operator and his family, although full-time or seasonal labor may be employed in larger farming operations. Land used in the production program may be either owned or rented. More typical farming operations in Missouri seem to include both owned and rented land.

Management--sometimes considered as another farm resource--is the key to success in a farm business venture. The management role and its relationship to farm planning will be considered in greater detail.

THE JOB OF A MANAGER

The farm manager, first of all, is a decision maker. Successes and failures in the farm business depend largely upon the soundness of his managerial decisions.

The manager truly must be a "jack of all trades." He is confronted by a multitude of production and financial problems associated with his farming operations. The production and financial decisions are closely inter-related and neither can be ignored nor neglected in a successful farm business operation.

Two major categories of decisions are often recognized in farm management: organizational and operational. In organizing his farm business, the manager must evaluate his total "bundle" of resources and allocate them to different enterprises and phases of production in the most profitable way. This is the basis for the long-range farm planning procedures explained in this handbook. Organizational planning by the manager is a never-ending task as plans frequently need adjustment because of changing conditions.

Operational decisions involve the day-by-day tasks in operating the farm business. They, too, involve both production and financial phases of the farming operation.

All types of management decisions are influenced greatly by two factors:

(1) The accuracy and appropriateness of the data upon which they are based.

(2) The procedures used in the decision-making process.

Careful attention to both will help the manager avoid inefficiencies in production and, sometimes, financial disasters in his business decisions.

The manager has access to many sources of information to serve as a guide in his decisions. His own production and financial records over time--carefully analyzed and evaluated--should provide the basis for his managerial decisions. In addition, supplemental data from research bulletins, extension publications, market reports, news stories, and magazine articles can also be useful.

A logical and systematic procedure for thinking through problems will help the manager achieve greater success in his role as a decision maker. While haphazard procedures and off-the-cuff decisions may succeed occasionally, the magnitude and complexity of decisions confronting most farm managers today require a more thorough approach. A decision-making process which has proved useful to many farm managers involves the following:

(1) Inventory resources. Itemize all resources available to the family, including dollar values of all assets and liabilities and computation of net worth at the time planning is started.

(2) Establish goals. Clarify objectives the family hopes to achieve over the time period for which plans are made.

(3) Identify problems. Clearly specify the major obstacles to achieving established goals.

(4) Analyze. Evaluate the economic consequences of alternative plans and courses of action to overcome the problems and reach goals.

(5) Decide. Choose the plan or course of action which seems most promising for achieving family goals.

(6) Act. Systematically develop the chosen plan over a period of time. Make any capital investments in a sequence which will contribute quickly and substantially to higher earnings.

(7) Assume responsibility. Accept the consequences of decisions made.

(8) Control. Maintain managerial control over the entire operation with particular attention to investments, costs, and production efficiency.

(9) Evaluate. Continually evaluate performance of the total farm business and of individual enterprises through keeping, interpreting, and using good farm records.

(10) Adjust. Make changes in response to the periodic evaluations mentioned in Step 9.

Data from farms included in the University of Missouri Mail-In Record Program reveal factual information about many of these adjustments. Some of the trends over a period of years are summarized in the table on the opposite page.

THE NATURE OF FARM PLANNING

Farm planning is simply charting a course from where you are to where you want to be. The procedures and techniques involve the logical formulation of a "blueprint" or guide to achieve selected goals of the family. The nature of farm planning can be described in general:

(1) Farm planning is "forward planning." It involves the formulation of expectations for the future--particularly prices and costs.

(2) Farm planning is based on estimates of the future. Hence, regardless of precision in computation, the plans will always be approximations of future performance.

A Ten-Year Trend of Selected Items from Record Data of Cooperators in the Missouri Mail-In Farm Record Program

Record item	1965	1966	1967	1968	1969
Number of farms	280	196	247	367	361
Acres of cropland	379	365	447	408	437
Total capital managed	$156,696	$171,010	$205,794	$210,034	$225,370
Value of production	$ 38,443	$ 37,867	$ 38,252	$ 45,315	$ 48,474
Return to operator labor & mgt./operator year	$ 11,485	$ 8,292	$ 2,207	$ 8,931	$ 9,470
Return to capital & mgt. as a % of capital managed	11.15	8.35	4.90	7.89	8.01

Record item	1970	1971	1972	1973	1974*
Number of farms	404	393	341	444	445
Acres of cropland	444	482	495	509	NA
Total capital managed	$240,076	$256,431	$285,203	$367,297	$424,234
Value of production	$ 43,348	$ 57,423	$ 77,179	$111,833	$ 82,646
Return to operator labor & mgt./operator year	$ 2,227	$ 12,072	$ 24,925	$ 31,393	$ 2,223
Return to capital & mgt. as a % of capital managed	4.11	8.32	13.03	17.51	5.70

*Preliminary 1974 data. Acreage not available at time of printing.

(3) Farm planning serves only as a guide in decision making. The primary value lies in providing comparisons among alternative courses of action and in developing a logical and systematic procedure to carry out a chosen course of action.

(4) Farm planning procedures vary with the kinds of problems to be solved. They may embrace either the total farm business or a specific enterprise, investment, or farming practice. The time span of the planning also may vary from a few days to a period of several years.

FARM PLANNING TOOLS AND TECHNIQUES

A number of farm planning tools and techniques have evolved over a period of many years. In most cases, each has been designed for a specific purpose or purposes. One of the first tasks of the planner is to choose carefully the type of planning procedure, or method, most appropriate for the task at hand.

Budgets are basic to most planning procedures. A budget is simply a "dollars and cents" evaluation of a contemplated course of action in order to determine the economic consequences before it is undertaken.

While budgets are essential in all planning, they do not constitute the entire job. Budgets indicate what to expect, dollar-wise, from a course of action; they do not show how it can be achieved most efficiently.

The farm manager also must decide on specific production practices, physical arrangements, and operating procedures to fit the resources at hand. For organizational planning, this may involve specific, long-range plans for field layout, lanes, water management, farmstead arrangement, water supplies and distribution, landscaping and home modernization, and many other tasks.

A plan for a specific enterprise may involve more detailed analysis of a choice of facilities and operating procedures and of more precise arrangements for feed storage and processing, corrals for livestock, etc. These latter phases of planning may require more time than

the actual budgeting and may be equally important in assuring the financial success of the operation.

Several kinds of budgeting have been developed to serve particular needs and functions. Some are designed for developing and evaluating long-range plans for the total farm business--from the standpoint of physical production, capital requirements, and financial performance. Others, annual budgets, include plans for the total farm business unit on a year-to-year basis. Others provide for evaluating cash-flow performance through different time periods within the year or over a period of years.

Other budgeting procedures--often described as partial budgets--are designed for evaluating particular phases, such as individual enterprises, specific investments, and separate farming practices.

A brief description of these different kinds of budgeting will indicate their usefulness. Later sections of the handbook will include more specific procedures and worksheets for each and instructions for using them.

Long-range Farm Planning

Long-range farm planning procedures are used to evaluate a course of action that is expected to affect several phases of the farm business. Generally, the present or "benchmark" farm plan is compared with one or more proposed long-range farm plans in terms of profitability and financial soundness. Tools and procedures for total farm planning are discussed below.

A. Block or "Hand" Budgeting

Block budgeting is a way of comparing the economic consequences of alternative farm plans. By working with "blocks" or unit budgets of a particular enterprise, the total budgeting process may be completed rather quickly. Another unique feature is the separate evaluation of returns from crop and livestock enterprises.

Part IV of the handbook contains a suggested step-by-step procedure for doing block budgeting and a series of worksheets to simplify computations. The crop and livestock enterprise budgets contained herein further simplify the budgeting procedure.

B. Computer Budgeting

Two computer budgeting procedures developed at the University of Missouri are available for evaluating total farm and financial plans. These are: computer long-range budgeting and computer transitional budgeting.

Computer long-range budgeting is a procedure (similar to block budgeting) to compare the present plan with alternative plans. Basic planning information needed includes: balance sheet for the present plan, crop and livestock enterprise budgets, changes in investments, and overhead costs. Computer output includes: projected profit and loss statements, profitability measures, debt repayment and cash-flow analysis, and balance sheet analysis. An example printout is shown in Part IV.

Computer transitional budgeting is a procedure to test a proposed long-range plan over the initial start-up period. This procedure is necessarily more detailed and requires year-by-year projections on the transitional period (1 to 4 years). Information and computer output are similar to the computer long-range budgeting procedure. These computer programs are available through the University of Missouri Area Farm Management Specialists and require a fee to cover cost of computer service.

Annual Farm Planning

The primary feature of the annual budget is its analysis of production and returns for one production period. In contrast with long-range planning, current outlook data for prices and current production prospects are used in preparing the annual budget.

Annual farm planning, coordinated closely with record analysis, can be highly valuable in planning ahead for

each year's production within the long-time system of operation.

Part V of the handbook contains sample forms and instructions for preparing annual plans to aid in evaluating the potential performance of the overall farm business a year in advance. Some credit agencies require budgets of this kind as a basis for setting up budgeted loans and establishing a "line of credit."

A. Cash Flow Budgeting

Cash-flow budgets are required by many creditors for projecting the flow of cash in and out of the farm business for specific time periods--either by months or quarters within a year or by years through the term of an intermediate term loan. Estimated cash expenditures for family living usually are included along with cash flow from farm business transactions. Sample forms and instructions for their use are included in the Missouri Looseleaf Record Book.

Partial Farm Planning

Partial plans can be quite useful to farm managers in making specific kinds of decisions. The distinguishing feature of partial budgets is their concern with only one practice or investment within an enterprise. They are used as a guide in decisions which do not affect the overall organization of the farm business. Several kinds of partial budgets are available, each designed for a specific purpose.

A. Partial Budget

This budgeting procedure has a variety of uses. It provides space for computing and summarizing the expected "gains" and "losses" resulting from an adjustment or change within an enterprise or within some phase of the total farm business.

Several questions relative to the proposed change may be explored, after the basic computations are completed.

Another form of partial budget is a "breakeven" budget in which one may determine the volume of production necessary to justify a given investment. This is often used in determining the acreage of harvesting necessary to justify an investment in a piece of equipment, in comparison with custom hiring. Other forms of breakeven budgets are used to determine the breakeven selling price for fat cattle or market hogs, assuming certain levels of variable costs to be covered in the analyses.

BASIC ECONOMIC PRINCIPLES AND RELATIONSHIPS

Understanding the basic economic principles and relationships helps to reinforce our effectiveness in predicting the outcome of many farm management decisions. They describe established physical and financial relationships that may be expected with certain changes. A brief summary of these principles and relationships follows.

Principle of Diminishing Returns

This principle states that when successive units of one resource are added while all other resources are held constant, the total "output" or production tends to: (1) increase at an increasing rate, (2) increase at a decreasing rate, (3) reach a maximum, and (4) decrease if further amounts are applied.

An example of the diminishing returns principle is shown in the figure on the opposite page.

The first 50-pound unit of nitrogen added 26 bushels of corn per acre in this study. As successive 50-pound units of nitrogen are applied, the total yield increases but the added yield response is less. Finally, at 200 pounds of nitrogen, the added yield is only 2 bushels per acre. It is likely that another 50-pound unit would have decreased the total yield per acre.

Maximum Profit Point

To maximize profits, continue to add successive units of a resource (such as fertilizer, labor, land, water, etc.) to the point where the added cost of the last unit of the resource is equal to the added returns.

Added Cost	=	Added Returns
(added unit x cost/unit)		(added yield x price/unit)

Cash farm receipts: These are the cash dollars received from the sale of farm products and all other cash income from the farm business.

Inventory changes: Inventory decreases of productive resources during the accounting period are costs against the business operations--just as inventory increases are added returns. Depreciation is included on depreciable items.

Family living costs: While separate from farm business costs, they must be considered by the farm family in planning and evaluating total operations. These, too, often are separated into (a) ordinary cash costs, such as current expenditures for food, clothing, health, recreation, etc., and (b) other costs, including new investments, life insurance premiums, etc.

B. Cost Concepts Used in Economic Analysis

Total fixed costs represent farming expenses of an "overhead" nature and do not change with output. They must be paid even if nothing is produced and are no greater under high yields.

Total variable costs refer to farming expenses which do change with output. They do not occur if nothing is produced and their amount depends upon what is produced.

Total cost is the sum of fixed and variable costs.

Average cost or average total cost is the pro-ration of the total costs among the various units of output (total costs ÷ units of output).

Average variable cost is the proration of the variable costs among the various units of output (total variable costs ÷ units of output).

Average fixed cost is the total fixed costs pro-rated among the various units of output (total fixed costs ÷ units of output).

Marginal cost is the addition to total cost associated with production of each last additional unit of output or product.

Marginal factor cost is the increase in total cost associated with using an additional unit of an output.

Opportunity cost (or equal marginal returns principle). The cost of using a resource, or factor of production, in one way is the return that would have been received from the same resource used in its most profitable alternative use.

Replacement cost is the total cost of adding one more unit of input (productive asset or factor) to a business.

HANDOUT

TABLE C-2. CORN BUDGETS

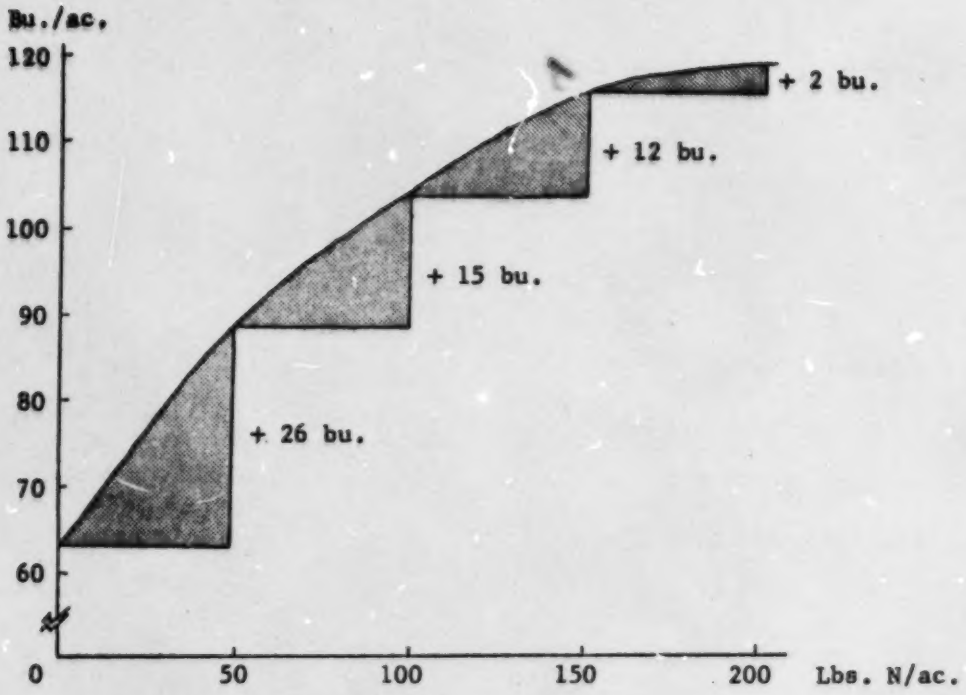
Description of Production: 5-16" plow; 16.5' disk; 27' sprayer; custom spread fertilizer; 6-30" row planter and cultivator; 3-30" combine and corn head; grain dried and stored on farm.

			MY FARM
1. Yield, bu. per acre (13% moist.)	80	100	_____
2. Price per bushel[1]	$ 2.15	$ 2.15	$_____
3. Gross income per acre	$172.00	$215.00	$_____
4. VARIABLE COSTS PER ACRE:			
5. Seed (50¢ per 1,000)	$ 10.00	$ 10.00	$_____
6. Fertilizer and lime[2]	36.50	45.00	_____
7. Crop chemicals and supplies	14.00	14.00	_____
8. Custom machine hire	2.00	2.00	_____
9. Machinery: fuel, oil, repairs	14.00	16.00	_____
10. Drying, 6¢ per bu.	5.00	6.00	_____
11. Storage, 5¢ per bu.	4.00	5.00	_____
12. Miscellaneous	5.00	5.00	_____
13. Other: _____	--	--	_____
14. Interest[3]	4.00	4.50	_____
15. TOTAL VARIABLE COSTS	$ 94.50	$107.50	$_____
16. INCOME OVER VARIABLE COSTS	$ 77.50	$107.50	$_____
17. Labor hours	4.0 hrs.	4.2 hrs.	_____hrs.

[1]Price is expected 3-year average annual price at the farm.

[2]Fertilizer costs are estimated: N (anhydrous) @ 15¢, N (dry) at 20¢, P_2O_5 @ 20¢, and K_2O @ 10¢ per pound for typical application rates. Annual share of liming cost is estimated at $2.50 per acre. 80 bu. yield: 120-50-60. 100 bu. yield: 150-60-80.

[3]Interest charge is computed at 9% per annum on one-half of Items 5 through 13.



Average Corn Yield for Nitrogen Treatment
on Seymour Silt Loam, 1961-67
(from data reported by Dale Colyer and
Earl Kroth, University of Missouri)

Substitution Principle

The substitution principle is used to determine the least-cost method of producing a given level of output. This principle states that costs can be lowered by substituting one resource for another resource (e.g., wheat for corn) if the cost of the first is less than the cost of the second.

Supplementary and Competitive Relationships

Enterprises that can be added without reducing or interfering with other enterprises are supplementary.

Enterprises are competitive when the expansion of production of one enterprise results in decreased production of another enterprise. Practically all crop and livestock enterprises become competitive at some point.

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Cost Concepts

There are numerous cost concepts which have an essential bearing on the success of modern farm businesses. An understanding of these costs will enhance the ability of the farm manager to realize satisfactory profits from his farming operations. Some of these are summarized below.

A. Farm Accounting Classification

Cash operating costs or cash expenses: The actual cash outlays during the accounting period for inputs used in the farm business, services, upkeep of buildings and equipment, taxes, insurance, interest paid, etc. They ordinarily include both fixed (overhead) costs and variable costs, defined later.

Cash farm expenditures: Under some accounting systems, these include--in addition to the above expenses--the cash outlays for all new investments for livestock, new farm machinery, service buildings, etc.

EVALUATION

1. What is a budget?

2. Name two resources used in developing a budget?

3. List 5 decisions that can be made using a budget.

4. Complete the following sample budget for corn production.

1. Yield, bushell per acre (13% moist)	120
2. Price per bushell	$ 3.30
3. Cross Income per acre	----
4. Variable Costs Per Acre:	
5. Seed (50¢ per 1000)	12.00
6. Fertilizer and Lime	40.00
7. Crop Chemicals and Supplies	12.00

8.	Machinery (fuel, oil, repairs)	15.00
9.	Drying (6¢ per bushell)	-----
10.	Storage (5¢ per bushell)	-----
11.	Miscellaneous	5.00
12.	Cost of fuel adjustment (20% of $10.00 per acre fuel costs)	-----
13.	Interest (10% per annum on one-half of Items 5 through 12.	-----
14.	Total Variable Costs per acre	-----
15.	Income Over Variable Costs	-----
16.	Labor Hours	4.0

LOW ENERGY TECHNOLOGY
AGRICULTURAL ECONOMICS: PLANNING FOR ENERGY SAVINGS

UNIT: FARM MANAGEMENT

MODULE: ENERGY SAVING IN AGRICULTURAL PRACTICES

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. List and explain at least five cultural practices that result in energy savings.	Cultural practices resulting in energy saving - Equipment in top condition - Cultivate shallow - Pre-emergence selective sprays - Narrow row spacing - Minimum tillage - Multiple cropping - Herbigation - Crop rotation - Soil testing	Read Handout: Cultural Practices that Yield Energy Savings . After completing the reading assignment study the examples of energy saving that could result from double cropping fertilization spreader, calibration, and soil testing. Then develop a checklist of energy saving practices which could be put into operation around your home or farm.
2. Give a written explanation of integrated pest management.	Integrated pest management - Crop selection - Disease resistant varients - Field monitoring - Biological control Result: Fewer chemical applications for pest control.	Read Handout: Integrated Pest Control. Additional Reading: Energy Conservation in Field Crop Production.

LOW ENERGY TECHNOLOGY
AGRICULTURAL ECONOMICS: PLANNING FOR ENERGY SAVINGS

UNIT: FARM MANAGEMENT

MODULE: ENERGY SAVINGS IN AGRICULTURAL PRACTICES

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
3. List and explain at least three irrigation practices that would save energy.	Irrigation practices that result in energy savings - Less pumping through the use of drip irrigation - Replacing open header ditches with plastic pipe - Operate irrigation equipment at maximum effeciency - Full bed plastic mulch	Read Handout: Irrigation. Energy Conservation in Field Crop Production.
4. Compare and contrast "Drip" and "Gun" irrigation systems in terms of energy savings.		After completing the reading assignments, list those irrigation practices which could result in energy saving in your home or on your farm. For the example of energy savings by maintaining irrigation equipment in efficient conditions, use current fuel prices, and recalculate all costs.

CULTURAL PRACTICES THAT YIELD ENERGY SAVINGS

Preparation of a seedbed for vegetable crops is an involved process. Debris from previous crops, or anything that would interfere with planting and other operations, must either be removed or blended into the soil. Generally, the soil is disked, plowed, harrowed, rolled, or dragged. A seedbed is usually shaped through the use of special equipment, and seeds or transplants are planted on the tops of the shaped seedbeds. During the growing season plants are continually cultivated to control weeds and thus conserve soil moisture and nutrients. To reduce energy consumption and costs:

- Keep Equipment in Top Condition

  Always have cultivating equipment in proper running order. Make certain that sweeps, shoes, shovels, and other cultivating equipment are in proper shape. Don't let the equipment develop dull leading edges. When possible, hardface cultivating equipment so that cutting edges remain sharp as they wear, thus reducing unnecessary friction.

- Cultivate Shallow

  Don't cultivate any deeper than necessary. The deeper you cultivate, the greater the fuel requirements, and the more damage you do to the plants' root structure. Cultivate while weeds are in the seeding stage. Timeliness is important in doing the most good with each cultivation and holding repetition to a minimum.

- Use Pre-emergence Selective Sprays

  Take advantage of pre-emergence selective sprays where feasible. These materials can eliminate mechanical cultivation, thus avoiding soil compactions and root damage. Consult your Agricultural Extension Service and chemical field representatives for appropriate sprays.

- Narrow Row Spacings

  Consider closer row spacing and greater plant density per acre. Various agricultural experiment stations are finding that closer row spacings result in higher yields per acre and reduced weed problems as plants cover the ground surface sooner, thus shading potential weed undergrowth. Oregon State University has found that narrow rows of beans close up faster, shading the ground sooner. Using good initial weed control via a pre-emergence spray may thus eliminate cultivation altogether.

- Herbigation

  Where overhead sprinklers are used, growers frequently add fertilizer (nitrogen) through the irrigation system. Herbicides and insecticides can also be applied that way, keeping cultivation to a minimum. However, at this time only one herbicide has broad registration for application through irrigation systems. Consult your chemical dealer and Extension Service for advice on herbicides and herbigation.

. Crop Rotation

If feasible, try to rotate crops. Successive cropping encourages a build up of weeds, diseases, and insects. Depending on the crops and regions, some weeds and insects can be controlled by crop rotation. Alternate shallow rooted plants with deep rooted plants. Switch between crops supplying large quanitites of organic matter and those crops that help break it down. Use soil-improving crops when land is not occupied with a money crop.

Most vegetable crop failures resulting from poor pest management trace back to improper selection of insecticides, poor timing of application, unfavorable weather conditions, insufficient rate of application, equipment failure, or operator negligence.

. Variety Selection

Selecting new varieties that are better adapted to certain enviornmental conditions or changing market situation can increase yields without increasing energy requirements. By planting appropriate pest-resistant varieties, losses from diseases, nematods, or insects can be reduced. Selecting an appropriately resistant variety can also reduce the dependence on pesticides and consequently, energy requirements for crop production. In many cases, varietal resistance is the most effective method to combat certain pests.

. Minimum Tillage

Tillage operations are kept to a minimum by using one operation to place the seed into an unprepared seedbed. Herbicides are used to kill vegetation normally controlled by tillage practices. The U.S. Department of Agriculture estimates that 5.32 gallons of diesel fuel are needed for each acre under conventional tillage compared to only 0.88 gallons needed for each acre under minimum tillage.

. Multiple Cropping

With this technique, two or more crops can be grown on the same land within one year. In most cases, there will be greater utilization of fertilizers, equipment, building and labor on a year-round basis with multiple cropping rather than single cropping. Multiple cropping will generally reduce the energy requirements when compared to growing the same amount of product in a single cropping system.

. Soil Testing

Soil test may yield indirect savings in energy by indicating the need for less fertilizer than might otherwise be used. One of several important pieces of information obtained from a soil test is the level of residual fertilizer nutrients already in place. Example: A grower produces 200 acres of sweet corn. Based on peat or much soil, the recommended fertilizing rate is 0-120-180 pounds of nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O, respectively.

The average adjustment recommended on this type of soil is a one-third reduction in the recommended amount of phosphorus if the level of residual phosphorus is medium, and a one-third reduction in potassium if residual potassium is medium. High residual levels call for a two-thirds reduction.

$8.40 per acre savings from soil tests.

Soil tests may also indicate a need for lime, micronutrients, or other adjustments in the fertilizer program which can in turn require adjustments in N-P-K recommendations. These adjustments are not necessarily always downward.

The following table shows the possible annual savings in fertilizer and dollars resulting from soil tests.

	Fertilizer					
	Phosphorus			Potassium		
	Residual level					
	Avg.	Med.	High	Avg.	Med.	High
Fertilizer savings lbs.	0	40	80	0	60	120
Dollar savings/acre	0	8.40	16.80	0	5.70	11.40
Dollar savings with 200 acres	0	1,680	3,360	0	1,140	2,280

Phosphorus 21¢/lb. potassium 9.5¢/lb

Double-Cropping Mulched Fields

Double-cropping under full-bed black plastic mulch culture yields direct energy savings by allowing the production of a second crop without the usual fuel-consuming pre-plant operations. It also yields an indirect energy savings through the production of a second crop with less additional fertilizer than the second crop would have required had it been grown under conventional culture, since less of the unused fertilizer is leached away.

$40.12 savings per acre in fertilizer costs using mulch culture.

Example: Using full-bed mulch culture, a grower produces tomatoes followed by cucumbers. If the cumcumbers are produced under conventional culture, a total of 2,975 pounds of fertilizer per acre is recommended for the production of both crops on this particular soil. The estimated cost for fertilizer is $225.72 per acre.

If cucumbers are produced on the same mulched field, a total of 2,180 pounds of fertilizer per acre is recommended. The estimated cost for fertilizer is $185.60 per acre. Production of cucumbers on the same mulched field yields an estimated savings of 795 pounds of fertilizer and $40.12 per acre.

Proper Calibration of Fertilizer Distributor

A properly calibrated distributor saves energy indirectly by reducing fertilizer waste. Each time you use a distributor, check to make sure the proper application rate is set. The rate is influenced both by the granular characteristic of the fertilizer and by the humidity.

$6.38 per acre savings from proper calibration of equipment.

Example: A grower plans to distribute 1,000 pounds of fertilizer per acre with a drill. The rows are 30 inches apart. At a given setting the fertilizer drill is applying 6¼ pounds per 100 feet of row. A standard chart indicates that 5-3/4 pounds per 100 feet or row is equivalent to 1,000 pounds of fertilizer per acre.

Without recalibrating, approximately 85 pounds of fertilizer material per acre would be wasted. The following table shows the dollar savings obtained by recalibrating to 5-3/4 pounds per 100 feet of row given selected fertilizer costs.

Cost per ton of fertilizer	Savings per acre from recalibration
	Dollars
150	6.38
175	7.44
200	8.50
250	10.62
300	12.75

Integrated Pest Control

The best pest control technique is to develop an integrated program which can lead to fewer chemical applications and greater crop yields.

This program should begin with crop selection based on those crops that are best suited to the general geographic area. Next, seeds or plants should be selected that are disease free and of the best quality.

Planting dates as indicated by extension agents, seed fieldmen, and previous personal experience should be followed closely. While deciding on the crop to plant, the grower should also be learning from extension agents and chemical salesmen about pests, pest hosts, beneficial predators, various selective chemicals, and critical application periods. The critical period for insecticides is the minimum number of days before harvest when a particular chemical can be used; for pests it is the time that they are most susceptible to the insecticides; for plants it is the time that they are most susceptible to various pests. Other cultural practices conductive to good vigorous growth should be followed. Healthy, growing plants can generally tolerate and resist more pests and diseases than unhealthy plants.

Fields and crops should be monitored carefully and frequently for pests. Insecticides should be selected with beneficial predators in mind. Crop residues can act as harborers of insects and reservoirs of diseases and should be plowed under as soon after harvest as possible.

Crops should be rotated to avoid certain pest and disease problems that can occur as a result of successive cropping.

Following an integrated pest control program should enable vegetable growers to reduce the number of times a given crop requires treatment for insects and pests. In this way, fuel should be saved, energy costs reduced and long-term profits improved.

Equipment and Operators

When applying insecticides, make certain that the equipment is properly calibrated, spray nozzles are of proper size and are clean, and that pump and motor are working efficiently. Operators should be properly trained and should understand the dangers inherent in chemicals.

Examples of Energy and Fuel Savings With an Integrated Pest Control Program

An integrated pest control begins with knowledgeable growers working with chemical field representatives and extension agents. A key to the integrated pest control program is an awareness of beneficial predator insects. Indiscriminate spray programs are to be avoided. The most selective sprays available should be used. Focus in on crop-damaging insects and not all insects. Good farming should be incorporated into the soil immediately after harvest. With an integrated pest control program, growers can usually reduce the number of required spray application over the long run. Assume the number of applications required is reduced by one.

$61.00 annual fuel savings on 10 -acre vegetable farm using 20 gal of diesel

Calculations:

10 acres X 2 gal/acre = 20 gal

Value of fuel saved at $1.30/gal, 20 gal = $26.00

Diesel Savings at Various Fuel Prices

Cents/gal	1.00	1.30	1.60	2.00
Savings/year	22.00	26.00	32.00	40.00

Fuel savings $26.00

Labor savings X 1 hour/acre @ $3.50 hour = $35.00

Net savings $61.00

Irrigation

Irrigation can account for 60 percent or more of the energy used in vegetable production. Using water and irrigation equipment more efficiently can conserve energy and reduce pumping costs. The following suggestions are offered to help you reduce fuel and electricity consumption in irrigating vegetable crops:

1. Using drip irrigation can double the efficiency of water use by reducing the amount of water that must be pumped. Less pumping means a savings of energy dollars.

2. Replacing open header ditches in sandy soils with plastic pipe for delivering water to field ditches can save up to 50 percent of the water needed for irrigation.

3. Operating irrigation equipment at maximum efficiency will conserve energy and save on irrigation costs.

4. Using full-bed plastic mulch can reduce water losses due to evaporation saving water and conserving energy used in irrigation.

In addition to direct energy savings, some of these practices may increase yield per acre, save labor, water, and fertilizer, and reduce disease problems.

Energy saving techniques are not limited to reducing fuel consumption. Every time the farmer reduces any form of energy, (mechanical, electrical, etc.) he is reducing the dependancy on the limited petroleum reserves.

Direct energy savings can be attributed to different cultivation, irrigation, fertilization, and practices. Each farmer should examine his own operation and analyze those practices that pertain to his operations. By using some energy saving techniques he may be able to save energy and increase his profits.

Example of Energy Savings by Maintaining Irrigation Equipment in Efficient Condition.

Keep irrigation equipment in top shape by repairing leaks in valves, pipes, and risers. Check gaskets in the sprinkler lines for leaks which waste water and power. Gaskets are easily replaced. Inspect your sprinkler nozzels. They enlarge after being used awhile and may apply water at a greater rate than needed. Enlarged sprinkler nozzels also shorten the distance water is thrown, overload the pump, and cause a pressure drip that increases the droplet size. Investigate the efficiency of the well. Clogged perforations or water screens at the water bearing strata may prevent water flowing freely into the well.

Suppose that inefficiencies in the irrigation system due to lack of maintenance result in a 5 percent increase in the workload of the pump unit. On a 40 acre field using a medium power system (60psi) and a 200 foot lift delivering 30 acre inches per crop year, this increased workload can cost an additional $100.00 per year or more.

Although the cost of materials used in maintenance may well exceed energy cost savings, other benefits such as these can be an accrual of better water distribution and increased equipment life.

$114.75 savings per year per 40 acre field

Calculations:

2.5 AC ft X 51 gal/AC ft = 127.5 gal of diesel

127.5 gal X .05 energy loss X 40 AC X $1.35 ga; = $344.25

Dollars saved at various diesel fuel prices

cents/gal	.40	.45	.50
Savings/year	$357.00	$369.75	$382.50

Calculations:

2.5 AC ft X 610 kWh/Ac ft = 1525 kWh

1525 kWh X .05 energy loss X 40 AC X

$.03 kWh = $91.50

Dollars saved at various electrical rates

Cents/kWh	.05	.06	.07	.08
Savings/year	$152.50	$183.00	$213.50	$244.00

Example of Savings From Use of Drip Irrigation

Savings from the use of drip irrigation result from increased efficiency in water use and from applying water at relatively low pressure. In one California test area where water costs amounted to $100.00 per acre, drip irrigation reduced water use by two-thirds. Water must be pumped at pressures up to 125 pounds per square inch with some conventional irrigation systems. Drip irrigation water can be applied at pressures as low as 10 to 20 psi.

$7770.00 savings on 160 acres of tomatoes

Example: A grower has 160 acres of processing tomatoes requiring 2 feet of irrigation water per acre applied with a high pressure gun system. By using trickle irrigation the water requirement can be reduced to 1.3 acre feet. The average lift for water is 50 feet. Total head for the high pressure gun system is 325 feet; for the drip system it is 85 feet. Initial cost for the present system is $275.00 per acre, for the drip system, $400.00 per acre. Operating costs for the two systems and energy savings are shown below:

Extimated direct energy savings on 160 acres of tomatoes from using drip irrigation

Cents/kWh	5¢	6¢	7¢	8¢
Savings/year	$6475	$7770	$9065	$10,360

Table 7 - estimated operating cost for drip and high pressure gun irrigation systems

ITEM	DRIP	GUN
	----------Dollars per acre ----------	
Materials	1.25	1.50
Labor	7.80	12.00
Pumping	9.96 (166 kWh)	58.50 (9.75kWh)
Other	1.75	2.25
TOTAL	20.76	74.25

EVALUATION

1. List and explain five cultural practices that result in energy savings.

2. Describe integrated pest management and state how it can be used to conserve fuel.

3. List and explain at least three irrigation practices that would save energy.

4. Compare and contrast "Drip" and "Gun" irrigation systems in terms of energy savings.

LOW ENERGY TECHNOLOGY
AGRICULTURAL ECONOMICS: PLANNING FOR ENERGY SAVINGS

UNIT: FARM MANAGEMENT

MODULE: ENERGY SAVING IN FIELD EQUIPMENT

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. Calculate the fuel costs for different types of tractors; given the price for fuel, tractor horsepower, fuel usage rate, and hours of operation. 33	Given the following information - 75 HP tractor/diesel, gasoline or LP gas - 500 hours of operation annually at full engine R.P.M. - Annual fuel consumption Diesel 1, 833 gallons Gasoline 2, 675 gallons LP gas 3, 210 gallons	Read Handout: Savings for Field Equipment. Read Handout: Selecting Power Equipment to Save Energy. After completing the reading assignment, the students should construct a chart to show the cost of operating a 75 HP tractor 500 hours annually with various fuels, i.e. diesel, LP gas, and gasoline. Students are advised to use current prices for each of the fuels listed.

LOW ENERGY TECHNOLOGY
AGRICULTURAL ECONOMICS: PLANNING FOR ENERGY SAVINGS

UNIT: FARM MANAGEMENT

MODULE: ENERGY SAVING IN FIELD EQUIPMENT

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
2. Calculate the amount of fuel lost in unnecessary idling of tractor engines.	Tractors idle for more than 12% of their total hours of operating - To conserve fuel, shut down the engine.	Read Handout: Tractor Operations for Fuel Savings . Read Handout: Energy Saving by Reducing Idling Time of a Tractor . After completing the reading assignment, calculate the cost and the amount of fuel consumed in a years time by a tractor left idling 20 minutes/day. Assume an idling tractor uses .5 gal/hr. Use current prices for fuel.

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LOW ENERGY TECHNOLOGY
AGRICULTURAL ECONOMICS: PLANNING FOR ENERGY SAVING

MODULE: FARM MANAGEMENT

MODULE: ENERGY SAVING IN FIELD EQUIPMENT

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
3. Calculate the difference in fuel consumption between tractors equiped with bias ply tires, and radial ply tires.	Radial ply tires are the most efficient in converting horsepower to drawbar pull. Fuel consumption/acre is decreased, acres cover/hour is increased. Tire slippage is reduced, and the ride is much smoother.	Read Handout: Energy Saving with Radial Ply Tires. Example of Energy Savings by Using a Diesel Tractor.
4. Identify three reasons why fuel savings occur when using radial ply tires.	Sources of fuel savings - Less tire slippage - Easier rolling force - Larger equipment pulling capacity	After reading the handouts, calulate the fuel savings possible in 1000 hours of operation. Use current fuel prices and assume that all information in the example is correct.
5. Determine the proper amount of front and rear ballast required for maximum fuel economy in a tractor.	See Florida Cooperative Extension Service Brochure "Tractor Ballasting to Conserve Fuel" E.C. - 19.	Read Handout: Tractor Ballasting to Conserve Fuel. After completing reading assignment select a tractor to work with and: - Measure wheel slippage - Check tire traction - Determine, by the general rules of tumb given in the reading the proper amount of front and rear ballast necessary for optimum fuel efficiency.

LOW ENERGY TECHNOLOGY
AGRICULTURAL ECONOMICS: PLANNING FOR ENERGY SAVINGS

UNIT: FARM MANAGEMENT

MODULE: ENERGY SAVINGS IN FIELD EQUIPMENT

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
6. List three fuel tips that will reduce fuel consumption by farm tractors.	Fuel tips - Check fuel tank, lines, fuel pump and carburator for leaks - Keep tank full - Leave room for liquid expansion - Maintain usage records	Read Handouts: Fuel, Operation, and Maintenance Tips that Save Energy . Tune-Ups Save Fuel.
7. List five engine operating tips that will reduce fuel consumption by farm tractors.	Engine Operating tips - Avoid excess warmup - Avoid idling - Don't leave choke out - Engage clutch slowly - Select proper running gear - Check thermostat	Develop a series of checklists for all trucks and tractors found - in the school - around the home and farm Each vehicle should be checked to determine if it is operating at peak efficiency.

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
8. List five engine maintenance tips that will reduce fuel consumption by farm tractors	Engine maintenance tips - Check plugs - Check fuel mix - Regular tune-ups - Proper tire inflation - Regular maintenance of belts and lubricants Energy savings are possible by modifying operations and maintenance procedures.	Read Handout: Gasoline and Diesel Engines. Calculate the cost and the amount of fuel lost annually from a fuel line with a slow leak of approximately .25 gallons per 24 hour day. Use current prices of fuel. Caculate the cost and the amount of fuel that could be saved by tuning a tractor engine to peak efficiency. Assume a 75 HP gasoline tractor being used 500/hrs/year under full load and consuming approximately 5 gallons of fuel/hour of use. Use current prices for fuel.

TRACTOR AND TRUCK USE

All of the fuel saved through proper maintenance of tractors and trucks can be quickly lost with inefficient work routines.

Only a thcrough work analysis can rid a farm of fuel waste. No grand scheme can be presented for every farm because each is different. There are, however, pitfalls common to many operations. Some of the following examples may point out fuel wasters that you have been too busy to recognize in the course of pressing day-to-day demands. Most are easy to correct once discovered.

When fuel savings are the result of reduced operating time, as is usually the case, you will also save in non-fuel costs such as repairs, oil, grease, tires and the like than the money you save in fuel. Reduction in associated labor costs is another benefit from reduced operating time of tractors and trucks.

EXAMPLES OF SAVING ENERGY THROUGH CHOICE OF TRACTOR FUELS

Every farmer should be familiar with the efficiency of the various kinds of tractor fuels including diesel, gasoline, and LP gas. Most tractors now manufactured, even many of the smaller-sized units, use diesel fuel, but a rather wide selection of gasoline-powered tractors is available; some tractors operate on LP gas.

A rule of thumb: Given the horsepower and running time, a diesel tractor will use seven-tenths as many gallons of fuel as a gasoline tractor; an LP gas tractor will use 1.2 times as many gallons of fuel as a gasoline tractor. Not only are there differences in fuel requirements for a given power output, but there are differences in the cost and relative availability of the different kinds of fuels. All advantages point toward the diesel-powered tractors.

You may have a mixture of tractors with respect to kind of fuel, making it more economical to continue using your present tractors for while. When it is time to trade for newer machines, however, give strong consideration to going totally diesel.

If you are planning to purchase a new car or pickup, consider those with electronic ignition and radial tires because they provide better fuel economy.

Tractors with all-gear power transmissions are 25 percent more efficient on fuel than hydraulic drives even at reduced engine speed, and at part load as well as at full load, according to Nebraska tests (annual Nebraska Tractor Test Data). This consideration partly offsets the greater convenience of the hydrostatic transmission.

Example of Energy Savings by Using a Diesel Tractor

A 75 horsepower diesel tractor which is used 500 hours a year and operates at an average output of 50 horsepower will use about 1,833 gallons of diesel fuel per year. The same size gasoline tractor operating under the same condi will use about 2,675 gallons of fuel annually; a tractor fueled with LP gas will use about 3,210 gallons. The difference in total fuel cost on an annual basis can be substantial depending upon the price of the three kinds of fuel. If you now pay $1.30 a gallon for diesel fuel, $1.40 for gasoline and $.70 for LP gas, the yearly fuel bill would be $2,382 for diesel, $3,745 for gasoline or $2,247 for LP gas.

$1,362 annual savings using a 75 HP gasoline tractor operating 500 hours at 50 HP output.

Calculations:

75 HP gasoline tractor: Average 50 HP output at full engine speed 500 hours

5.35 gal per hr = 2,675 gal

2,675 gal X $1.35 = $3,611.00

75 HP diesel tractor: Average 50 HP output at full engine speed 500 hours

2,675 gal X .70 = 1,833

1,833 gal X $1.20 = $2,200.00

75 HP LP gas tractor: Average 50 HP output at full engine speed 500 hours

2,675 gal X 1.20 = 3,210

3,210 gal X .40cents/gal = $1,284.00

$3,611 (gasoline) - $2,200 (diesel) = $1,411.00

Fuel Cost at Various Prices Per Gallon of Diesel

Dollars Per Gallon Diesel	Total Fuel Costs per 500 Hours
$1.30	$2,382.90
1.40	2,566.20
1.50	2,749.50
1.60	3,666.00

Fuel Cost at Various Dollars per Gallon of Gasoline:

Dollars per gallon, gasoline	Total Fuel Cost per 500 hours
$1.40	$3,745.00
1.50	4,012.50
1.60	4,280.00
2.00	5,350.00

Fuel Cost at Various Dollars per Gallon of LP Gas

Dollars per gallon, LP gas	Total Fuel Cost per 500 Hours
$0.60	$1,926.00
0.70	2,247.00
0.85	2,728.50
1.00	3,210.00
1.25	4,012.00

Selecting Power Equipment To Save Energy EC-18

Stretch America's Vanishing Energy

FLORIDA COOPERATIVE EXTENSION SERVICE

Selecting Power Equipment To Save Energy

Richard Cromwell, Extension Agricultural Engineer

ENERGY CONSERVATION FACT SHEET

University of Florida • Institute of Food and Agricultural Sciences

The price difference between diesel and gasoline powered tractors has recently been decreasing. Diesel engines can now be chosen with an expected net savings in smaller tractors and tractors that are used fewer hours per year than was possible in the past.

This fact sheet provides the farmer with information needed to determine his annual fuel use for typical farm situations (both light and heavy work). This information can then be used to determine annual fuel cost and fuel savings in order to estimate the use hours needed to recapture the higher investment of the diesel tractor.

Another potential fuel savings dealt with is that realized from properly matching tractor power takeoff (PTO) driven equipment to the tractor so that the engine is working close to its rated load. This is very important because the tractor operator often cannot throttle back to a lower rpm when doing PTO work as he can to improve fuel efficiency when doing drawbar work.

DIESEL AND GASOLINE TRACTORS

Although the primary purpose of this fact sheet is to show the amount of fuel that can be saved by good power equipment selection, some consideration of the economics involved in purchasing a diesel tractor will be helpful. In general, a diesel tractor will save both fuel and money. In most farming situations, the potential for recapturing the additional investment is excellent.

Fuel Consumption

Diesel engines are more efficient users of fuel than gasoline engines. In fact, a diesel engine consumes about 70 percent as much fuel per unit of work as a gasoline engine does. This is due to the diesel's higher air compression ratio in the cylinder.

Figure 1 illustrates the compared compression ratios of gasoline and diesel engines. In gasoline engines, an 8 to 1 compression ratio is typical. In diesel engines, a 16 to 1 ratio is typical. The diesel's higher compression ratio results in a more powerful stroke, but it also requires diesel engines to be made stronger than gasoline engines.

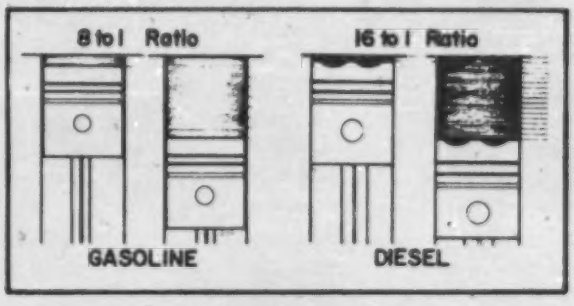

Figure 1. Compared Compression Ratios

Initial Cost

Because a diesel must be stronger than a gasoline engine, diesel tractors have historically been significantly more expensive than gasoline powered tractors. The decision to buy a diesel was often based on whether the additional expense would be recaptured through fuel savings in the planned use period. Now the difference between the initial cost of gasoline and diesel tractors is decreasing, which means that the hours of use required to make a diesel as economical as a gasoline tractor are decreasing.

Table 1 shows the price difference between gasoline and diesel tractors as quoted by dealers of three different makes. Because of the reduction in the initial cost difference, the decision to buy diesel or gasoline tractors appears to be shifting more in favor of the diesel. At least one manufacturer offers only diesel power in field tractors, and farmers who prefer this make have the decision made for them.

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Gasoline Engine

Diesel Engine

Table 1. Initial Price Difference Between Diesel and Gasoline Tractors

Tractor Make	Horsepower Ranges		
	30-40 hp	40-60 hp	60-70 hp
A	$240	$240	$240
B	$775	$745	$825
C	$330	$400	$500

PREDICTING FUEL CONSUMPTION

A farm tractor is generally used for all types of work. The horsepower demand of these services varies considerably from the maximum power available down to very light service which a much smaller tractor could perform. As an indicator of the fuel consumption in general farm service, it is a common practice to use averages from the "Varying Power and Fuel Consumption Test," which is one of the tests conducted by the University of Nebraska.

Here is an example of how a farmer might estimate the gallons of fuel that he will use in a year:

Example: A farmer uses his 66 horsepower tractor for approximately 700 hours per year. How many gallons of fuel will be used if the tractor is powered by (1) a diesel engine and (2) a gasoline engine?

The average fuel consumptions per hour given in the "Varying Power and Fuel Consumption Test" on the 66 horsepower tractors are:

Diesel — 3.08 gal/hr
Gasoline — 4.25 gal/hr

Thus, we find:

(1) Annual Diesel Consumption = 700 x 3.08
= 2,156 gallons
(2) Annual Gasoline Consumption = 700 x 4.25
= 2,975 gallons

The gasoline tractor would use 819 gallons more than the diesel in a year.

The above example utilized the actual fuel consumption figures 3.08 gal/hr and 4.25 gal/hr from a Nebraska Tractor Test Data Report. These reports are available from the University of Nebraska on many tractors; however, the following formulas for determining approximate fuel consumption of farm tractors in typical farm service can be used:

(1) Annual Diesel Consumption = Hours Use x Rated Horsepower x Diesel Consumption Factor
(2) Annual Gasoline Consumption = Hours Use x Rated Horsepower x Gasoline Consumption Factor

where:
Diesel Consumption Factor = .044 gal/hp hr
Gasoline Consumption Factor = .067 gal/hp hr

If the farmer in the first example wanted to determine his annual fuel consumption but didn't have the Nebraska Test Data, a good approximation could be figured knowing the maximum rated horsepower and the factors above.

(1) Annual Diesel Consumption = 700 x 66 x .044
= 2,032 gallons
(2) Annual Gasoline Consumption = 700 x 66 x .067
= 3,095 gallons

The relative fuel consumptions are helpful in deciding what type of engine should be chosen.

MATCHING MACHINERY TO THE JOB

An engine delivers the greatest fuel economy when it is worked at its rated load. Therefore, in order to achieve maximum fuel economy, select tractor power takeoff (PTO) driven machinery which will work the engine at its rated horsepower.

PTO Work

Matching equipment is important for both PTO and drawbar loads. However, it is especially important for PTO loads because in many instances the PTO driven machinery has to be driven at its rated rpm in order to work properly. A tractor operating at rated rpm but loaded at about 45 percent of its rated horsepower delivers about 80 percent as much work per gallon of diesel fuel and 70 percent as much work per gallon of gasoline as a tractor operating at rated load. In addition to the fact that a diesel engine is inherently more efficient than a gasoline engine, these percentages indicate that a partially loaded diesel engine also operates more efficiently than a partially loaded gasoline engine.

Figure 2 demonstrates the potential savings that can be made by using a fully loaded diesel tractor in comparison to a partially loaded diesel tractor, a fully loaded gasoline tractor, and a partially loaded gaso-

line tractor. This comparison accounts for the relative efficiencies of the diesel and gasoline engines as well as the relative efficiencies of full and part load operation. The partially loaded gasoline tractor uses more than double the amount of the fully loaded diesel for the same job.

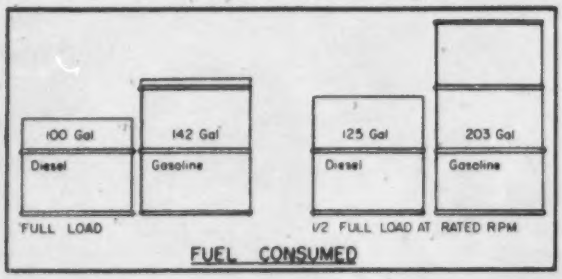

Figure 2. Comparison of Fuel Used for the Same Job by Half and Fully Loaded Gasoline and Diesel Tractors

Drawbar Work

Matching the tractor with the implement when doing drawbar work is not as important from a fuel efficiency standpoint as when doing PTO work. Drawn implements do not have to be operated at a particular rpm and the operator can shift-up to a higher gear and reduce engine rpm to get good fuel efficiency when operating at low loads. Naturally, farmers would prefer to match their drawbar equipment to the capabilities of the tractor in order to finish the job as swiftly as possible.

For further information, contact your County Extension Office.

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FLORIDA COOPERATIVE EXTENSION SERVICE

Tractor Operation For Fuel Savings

Richard Cromwell, Extension Agricultural Engineer

ENERGY CONSERVATION FACT SHEET

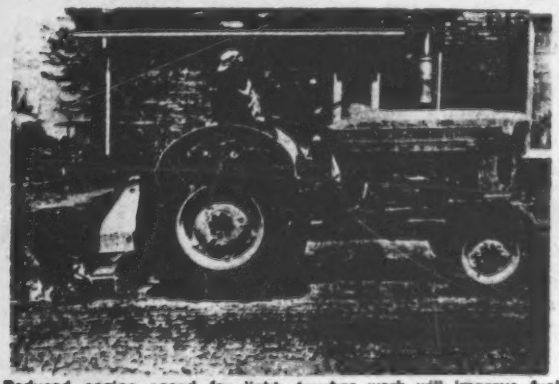
University of Florida • Institute of Food and Agricultural Sciences

The amount of tractor fuel required to perform a specific amount of work depends largely upon how the tractor is operated. The load, engine speed, gear used, amount of turning and amount of engine idle time can cause fuel consumption to vary considerably.

SHIFT UP—THROTTLE BACK

Ideally, a farmer should use an implement that will load the tractor engine to its rated capacity. Under these conditions, fuel efficiency will be close to maximum and the work will get done quickly.

Many jobs done by farm tractors do not require full rated capacity. In fact, studies indicate that on the average, a farm tractor is loaded to only 50 percent of its rated capacity. When performing light drawbar work, reducing the engine speed will improve fuel efficiency.



Reduced engine speed for light drawbar work will improve fuel efficiency.

This fact is proved conclusively by a test conducted during the Tractor Test Program at the University of Nebraska. A tractor is tested in the following manner:

1. The tractor is tested for maximum drawbar horsepower in a gear selected by the tractor manufacturer.
2. In the same gear, the tractor is tested pulling 50 percent of the maximum power run load.
3. The tractor is tested in a higher gear and at a reduced engine speed to maintain the same pull and travel speed as in run 2.

Results: During run 3, diesel tractors use about 75-80 percent as much fuel as during run 2, even though they are both performing the same amount of work. Gasoline engines also operate more efficiently during the lower speed run; however, the reduction is not as great.

Many diesel engines run more efficiently at 50 percent load and a reduced engine speed than at the 100 percent load and full engine speed. Because of this trait, a farmer can often use a large diesel tractor at reduced engine speeds for light drawbar loads and actually use less fuel than he would use with a smaller tractor working at its rated capacity.

A large diesel at reduced engine speeds for light drawbar loads may use less fuel than a smaller tractor working at rated capacity.

Figure 1 is from test data for a 50 horsepower diesel

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tractor. Note that the fuel efficiency increases as the horsepower output increases up to about 80 percent of the maximum horsepower produced at that engine speed. Further increase of power output causes the fuel efficiency to decrease. At partial load, the fuel efficiency improves as the engine speed is reduced. For the tractor tested, the best fuel efficiency was obtained at about 30 horsepower and 1400 rpm.

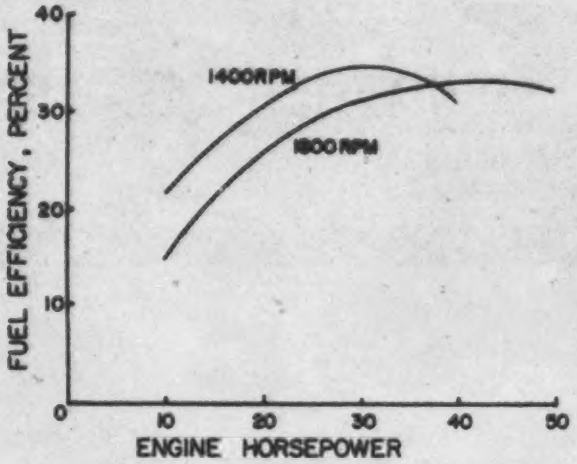

Figure 1. The Effect of Engine RPM and Output upon the Fuel Efficiency of a Diesel Tractor.

For maximum fuel efficiency, select the gear which provides the desired speed of forward travel at the reduced engine speed. On tractors having a wide range of gears, it is possible to have engine speeds which give nearly optimum fuel efficiency at the desired travel speed.

PTO WORK REQUIRES MATCHING

It is especially important to match tractors to the load when performing PTO work because PTO driven equipment usually must be operated at the rated engine rpm to perform properly. Although shifting up and throttling back will help achieve maximum fuel economy with light drawbar work, PTO operations at partial load do not offer this opportunity.

Shifting up and throttling back helps conserve fuel when doing drawbar work.

SHUTTING OFF THE ENGINE

An Illinois study showed that, on the average, tractors idle for more than 12 percent of their total hours of operation. An idling engine may use more than ½ gallon of fuel per hour. Rather than letting the engine idle for long periods of time, shut off the engine to help conserve fuel.

SUMMARY

- Operate the tractor at the rated load (rated engine rpm at full hand throttle) at all times.
- Combine machines to load the tractor to its rated capacity.
- When pulling light loads, shift up and throttle back.
- Don't idle the engine excessively.

For further information, contact your County Extension Office.

This fact sheet was promulgated at a cost of $184.18, or 1.8 cents per copy to inform tractor operators on ways to save fuel through correct tractor operation.

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS
(Acts of May 8 and June 30, 1914)
Cooperative Extension Service, IFAS, University of Florida
and United States Department of Agriculture, Cooperating
K. R. Tefertiller, Director

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ENERGY SAVINGS BY REDUCING IDLING TIME OF A TRACTOR

The typical farmer who uses a tractor in his work should be alert to fuel consumption problems that may be robbing him of earned income. For example, chances are that you leave the tractor engine idling when you step off to handle a quick chore. An idling engine does not use much fuel, and you have probably never given the matter any thought.

Suppose you leave the tractor engine idling for 10 minutes during an average day. During a year this amounts to 61 hours. Sixty-one hours of idling on a 75-horsepower diesel tractor will use about 30 gallons of fuel. This is a sizable amount of fuel, especially when it is accomplishing no useful purpose.

Make it a habit to turn off the tractor engine when you have some other work to do nearby. Some things will occur unexpectedly and you will not be able to turn off the tractor engine without making a special trip to do so. That may be impractical. On routine matters, however, you can certainly turn the engine off when you know that you will be working somewhere away from the tractor for a few minutes.

Calculation:

Present routine: Tractor engine idling unnecessarily an average of 10 minutes a day.

10 min X 365 days = 3,650 min

3,650 min - 60 = 61 hours

61 hours X 0.5 gal per hour = 30 gal

Improved Routine: Eliminate the unnecessary idling time and save 30 gallons of fuel

Cost of fuel per gallon	Savings per year
$1.00	$30.00
1.50	45.00
2.00	60.00

ENERGY SAVINGS WITH RADIAL PLY TIRES

Tractor tires are not direct energy users themselves except for the materials and energy used in the manufacturing process. However, the proper type, size and use of tractor tires can result in considerable energy savings.

The most familiar type of tractor tire is the bias ply tire which consists of layers of cord (plys) set diagonally to the tread and criss-crossed at an angle called a bias angle.

In contrast, the newer radial tires consist of plys that run at right angles to the tread. A belt of plys around the radial ply tire gives it strength and stability. The result, a tire with a flexible sidewall. A radial ply tractor tire is the most efficient tire in converting horsepower to drawbar pull. Fuel consumption per acre is decreased, area covered per hour is increased, tire slippage is reduced and the ride is much smoother.

Potential savings from use of radial tractor tires arise from three sources. There is less tire slippage resulting in more travel per engine revolution and easier rolling force resulting in less fuel used and longer tread life, and larger equipment pulling capacity since traction is increased and power loss is reduced.

Example of Energy Savings By Use of Radial Tractor Tires

Assuming 700 hours of mixed tractor work on a farm using standard tires, only 623 hours would be needed to do the same amount of work with radial tires. Fuel per hour would be 5.52 gallons for bias tires while 5.14 gallons would be needed for the radials, resulting in an annual fuel savings of $330.00 at /.50 cents per gallon for fuel. The reduction in labor costs for a tractor driver would be $231.00 at $3.00 per hour. Annual tire cost would be reduced to $68.00 from $80.00 because of additional tire life with the radials. Interest on investment would be increased from $13.00 to $21.00

April 1977 prices in Galesburg, Ill., for 18.4 X 38.6 ply radial tires were $605.00 plus $16.85 Federal exicse tax compared with $359.50 plys $11.59 excise tax for bias ply tires.

Comparative Annual Operating Costs:

	Bias Ply	Radial Ply
Hours of operation	700 hours	623 hours
Fuel per hour	5.52 gal/hr	5.14 gal/hr
Price of Fuel	$1.50/gal	1.50/gal
Total cost of fuel	$5,746.00	$4,803.00
Fuel Savings		993.00

Labor	700 hours	623 hours
Cost of Labor	$3.00/hr	3.00/hr
Total Cost of Labor	$2,100.00	$1,869.00
Labor Savings		231.00
Tire cost per year (85 percent of tread life)	$94.00	80.00
Tire Savings		14.00
Interest on investment at 8 percent	$14.00	24.00
Interest savings	10.00	
Total annual cost	$8,004.00	$6,776.00
Total annual savings		$1,228.00

Field Tire Test

	Radial ply	Bias Ply
Acres/gal	.87	.72
Acres/hr	4.47	3.98
Fuel efficiency %	120.8	100.0
Acreage efficiency %	112.6	100.0
Tire life %	165.0	100.0
Tire prices %	176.3	100.0

Adapted from material published by and research conducted by B.F. Goodrich Goodrich Tire Co., Akron, Ohio 44318

Fuel Cost at Various Dollars per Gallon of Gasoline:

Dollars per Gallon, Gasoline	Total Fuel Cost per 500 Hours
$1.40	$3,745.00
1.50	4,012.00
1.60	4,280.00
2.00	5,350.00

Fuel Cost at Various Dollars per Gallon of LP Gas:

Dollars per Gallon, LP Gas	Total Fuel Cost per 500 Hours
$0.60	$1,926.00
0.70	2,247.00
0.85	2,728.50
1.00	3,210.00
1.25	4,012.00

Stretch America's Vanishing Energy

FLORIDA COOPERATIVE EXTENSION SERVICE

Tractor Ballasting To Conserve Fuel

Richard Cromwell, Extension Agricultural Engineer

ENERGY CONSERVATION FACT SHEET

University of Florida • Institute of Food and Agricultural Sciences

Ballasting a tractor is the process of adding weight to the rear for increased traction and/or to the front for stability and good steering. An improperly ballasted tractor wastes fuel. Inadequate weight on the drive wheels causes excessive slippage, while too much weight increases the amount of horsepower required to drive the tractor through the field.

Rear Ballast

Effective Weight

The effective weight on the driving wheels determines how much a tractor can pull in the lower gears. Depending on the operating surface, the drawbar pull will be from 30-70 percent of the effective weight on the driving wheels. The effective weight is the combination of the tractor's rear tire weight, wheel weights, tire fluid, and weight transferred by hitch mounted implements.

Wheel Slippage

Since there is little control over the operating surface, slippage of the drive wheels must be controlled by adding weight. Tractors are designed to give maximum performance with about 15 percent rear wheel slippage. Slippage greater than 15 percent causes excessive tire wear and reduces tractor productivity. If wheel slippage is less than 15 percent, the tractor is possibly carrying too much ballast, placing extra stress on both the tires and the power train.

Tire Pressure

Before making adjustments for wheel slippage, check the rear tire pressure. Use a low pressure gauge and take the reading with the valve stem at the bottom of the rim. If calcium chloride is used in the tire, wash the gauge after using to avoid corrosion.

Measuring Slippage

To measure the amount of wheel slippage, complete the following steps:

1. Mark a reference line on the side of the drive wheel tire with chalk.
2. Drive the unloaded tractor for 10 complete revolutions and mark the distance traveled.
3. Drive the tractor while under full implement load and mark the distance traveled during 10 complete revolutions.
4. Determine the percent slip from the formula:

$$\% \text{ slip} = \left(1 - \frac{\text{distance traveled loaded}}{\text{distance traveled unloaded}}\right)100$$

Example: A tractor advances 96 feet with a load and 120 feet without a load. What is the percent slip?

$$\% \text{ slip} = \left(1 - \frac{96}{120}\right)100$$

$$= \left(1 - .8\right)100 = .2 \times 100 = 20\%$$

For most efficient operation, 20 percent is too much slippage.

Tire Traction Check

An approximate method for checking proper ballast is to observe the tire tread pattern produced when pulling under load, using the following guidelines:

Too little.—When the weight on the tires is too little, the tread marks are wiped out entirely due to excessive slippage, which reduces forward progress.

Too much.—When too much weight is used, the tire tracks will be sharp and distinct in the soil.

Proper weight.—When the tires are weighted properly, a small amount of slippage occurs. The soil between the cleats in the tire pattern is shifted, but the tread pattern is still visible. (Figure 1.)

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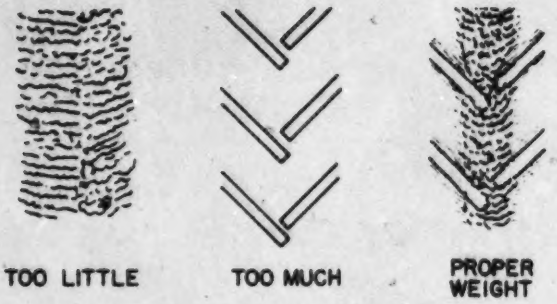

Figure 1. Tire Traction Patterns

Considerations

Avoid both too little or too much ballast. Too little ballast causes excessive slippage. Too much ballast increases the horsepower needed to move the tractor through the field and reduces the power available for pulling an implement. It also increases soil compaction which may retard crop growth.

Ideally, a tractor should be ballasted properly for any of the high draft operations in crop production, such as land preparation. The ballast should then be removed for the low draft operations. This ideal situation often cannot be practically achieved because one of the cheapest and easiest means of increasing ballast is to use liquid in the tires. Because of the special equipment needed for adding liquid ballast to tractor tires, it is usually regarded as a permanent part of the tractor. Cast-iron weights are the variable portion of the total ballast since they can be installed and removed with relative ease.

Dual Rear Tires

As engine horsepower of farm tractors increases, traction problems increase. Compaction of soil is also a major problem with bigger tractors. Dual rear tires are one way to add more weight for traction while reducing the compaction by spreading the weight over a larger area.

There are no universal guidelines for using or not using dual wheels. Each situation must be examined to determine the feasibility of dual tires. Consult your tractor dealer prior to installing duals to make sure the power train components can withstand the extra stress of dual tires.

Advantages

- Dual tires with added ballast give more ground contact. This reduces slippage, increases ground speed, improves work rates, and possibly reduces fuel consumption.
- Tractor stability is improved by the greater ground contact and tread width.
- Operator fatigue is lessened because the ride is smoother.
- Duals increase floatation when replacing single tires of the same size.
- Dual wheel tractors have a higher potential for all-season use.

Disadvantages

- Some tractor axles, bearings, and power trains may be overstressed by dual wheels, with resulting damage to the tractor.
- Other than reducing soil compaction, there is no economic gain in dual tires over single tires of the same size if the drawbar load is relatively light.
- Dual tires may make the tractor more difficult to turn and if short turns are made, the stress on the tread lugs may cause the lugs to tear.

Front Ballast

The requirements for front ballast vary widely between operations. Adequate ballast for stability during transport is important. However, weight added to the front for transport may not be needed for field operation. For example, a tractor with an 8-unit planter mounted on an integral tool bar needs front ballast for safe transport. But little front ballast is needed for stability when this implement is used in the field. The opposite is true of a semimounted plow. Little front ballast is needed for transport, while weight is needed during field operation to keep the front of the tractor in firm contact with the soil.

The amount of front ballast needed for transport may be difficult to determine, even with experience. The front wheels may appear to be in firm contact with the ground, but at higher transport speeds more weight may be needed on the front tires to steer the tractor. When uncertain as to how much ballast to use, it is usually best to add a little extra than not enough.

When determining the amount of field ballast required, the general rule of thumb is:

1. For mounted implements, ⅕ of the total tractor weight on the front and ⅘ on the rear.
2. For towed implements, ¼ of the total tractor weight on the front and ¾ on the rear.

These rules are considered a good starting point from which ballast can be added or removed as needed under field conditions.

For more information, contact your County Extension office.

This fact sheet was printed at a cost of $203.10, or 4.1 cents per copy, to inform operators on conserving energy.

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6-10M-76

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS
(Acts of May 8 and June 30, 1914)
Cooperative Extension Service, IFAS, University of Florida
and United States Department of Agriculture, Cooperating
Joe N. Busby, Dean

FUEL, OPERATION AND MAINTENANCE TIPS THAT SAVE ENERGY

Gasoline-and diesel-powered engines are the biggest onfarm users of energy in crop production.

The following examples and tips are important to the farm manager or owner. Saving energy by eliminating wasteful practices or changing techniques not only saves a valuable resource but will also reduce operating costs and therefore, increase profits.

FUEL TIPS

The saving of fuel begins even before you start your tractor, truck, or car. The following tips may save you fuel, dollars, and problems.

1. Check tank, lines, fuel pump, and carburetor for leaks.
2. Keep full tank, especially in cold weather, to avoid moisture condensation.
3. Check your usage against your bill.
4. When filling tank don't forget to leave room for expansion.
5. Maintain dispensing records by vehicle and task performed. This can identify high and wasteful usage.

ENGINE OPERATING TIPS

The way a vehicle is operated can save fuel without changing the amount of work or the way the work is done.

1. Avoid excessive warmups in cold weather.
2. Idling can consume 15 to 20 percent of the fuel used. Hold it to a minimum, and avoid excess idle speed.
3. Don't leave the choke out.
4. Let out the clutch slowly; quick starts waste fuel and are hard on equipment.
5. Run tractors in the proper gear for the load and condition. Improper shifting and use of the wrong gear can result in a 5 percent fuel loss.
6. Be sure the thermostat is working properly.

ENGINE MAINTENANCE TIPS

1. One fouled spark plug or one stuck valve lifter can cause a loss of 10-15 percent of the fuel used in a vehicle.

2. Too rich a mixture of fuel causes waste.

3. Too lean of a mixture waste fuel because it promotes excessive choke use.

4. Regularly scheduled tuneups can save up to 10 percent of your fuel usage.

5. Keeping the tires of your tractor and other implements properly inflated saves energy.

6. Improper lubrication, loose fan belt, or low oil level will increase fuel consumption.

Stretch America's Vanishing Energy

FLORIDA COOPERATIVE EXTENSION SERVICE

Tune-ups Save Fuel

Richard Cromwell, Extension Agricultural Engineer

ENERGY CONSERVATION FACT SHEET

University of Florida • Institute of Food and Agricultural Sciences

Farmers in the United States used slightly more than 4 billion gallons of gasoline in 1973. About 47 percent of this amount was used in tractors, 32 percent in farm trucks and the remainder in combines and other machinery.

Tuning up farm machinery to get the most work possible from every gallon of gasoline has always been a good practice, but the importance of engine tune-ups is even more obvious now because of higher fuel prices and eventual depletion of our fossil fuels. Increasing fuel efficiency by keeping engines tuned offers dollar savings as a short term benefit and also provides more time for scientists to develop alternative fuels needed for the type of farming done in the U.S.

The world is living on an energy savings account which will run out in the forseeable future if the present consumption rate of fossil fuels continues. Energy experts disagree on exactly when our fuel supplies will be exhausted because their opinions differ on how much practically utilizable reserves exist. But all of the experts agree that the supply will be exhausted within a relatively short time unless we develop alternate energy sources.

This fact sheet deals with tune-ups of gasoline engines used in tractors and other farm machinery. Although some suggestions might apply to the operation and maintenance of diesel engines, generally tuning diesel engines requires a greater degree of skill and more specialized tools and equipment. There is a strong trend toward more farm tractors being equipped with diesel engines and more service centers are being built to provide maintenance. Diesels don't require tune-ups as frequently as gasoline engines do, but the tune-up is just as important when it is needed.

SAVINGS POSSIBLE BY TUNING GASOLINE ENGINES

Research studies conducted by agricultural engineers from Kansas State University showed that the fuel consumption of 50 randomly selected farm tractors was reduced by nearly 14.5 percent by tuning them. In addition, the 50 tractors yielded an 11 percent increase in horsepower. This means that a farmer could reduce a 10 hour work day to 9 hours or do 11 percent more work in a normal day's time. In addition to the 13 percent fuel savings the 11 percent increase in horsepower could mean an even greater money savings to farmers in some areas of the United States because the timeliness of certain farming operations greatly influences crop yields.

Two examples of operations that must be performed within a relatively narrow time range if maximum harvests are to be realized are planting corn and harvesting soybeans in the Midwest. Each day of delay in either of these operations reduces yields by about one percent, so an 11 percent increase in horsepower should insure a greater harvest by reducing the time needed to perform these critical operations.

TUNE-UP OPERATIONS THAT CONTRIBUTE TO FUEL ECONOMY

Components of the gasoline engine that most commonly cause increased fuel consumption and loss of power because of improper service are the spark plugs, ignition timing, air cleaner, carburetor adjustment and engine governor.

Fuel consumption decreased 14.2 percent when new plugs were installed.

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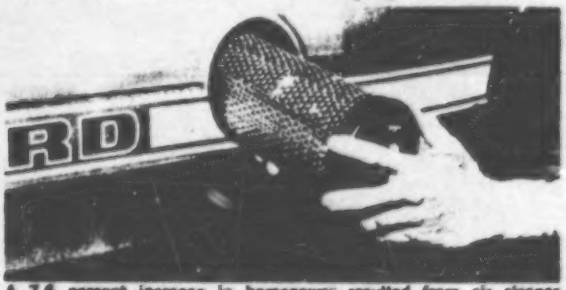
COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS, STATE OF FLORIDA, IFAS, UNIVERSITY OF FLORIDA, U. S. DEPARTMENT OF AGRICULTURE, AND BOARDS OF COUNTY COMMISSIONERS, COOPERATING

The following summary of research by Kansas State University shows improvements in efficiency realized by various tune-up procedures:

(1) **Ignition timing** was off on 53 percent of the tractors tested. By correcting ignition timing, horsepower increased 3.3 percent and fuel consumption decreased 3.3 percent.

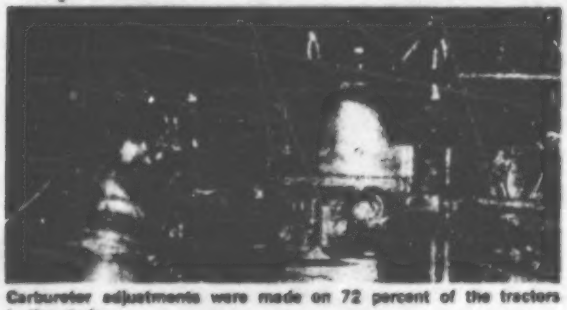
(2) **Spark plugs** were replaced in each tractor unless new plugs had been installed within two weeks preceding the test. Plugs were replaced in 90 percent of the 30 tractors tested. Horsepower increased an average of 3.6 percent and fuel consumption decreased 6.1 percent after spark plugs were installed.

Seven of the tractors tested misfired under load. In all seven cases, misfiring was eliminated by new spark plugs. Power was increased an average of 21.5 percent and fuel consumption decreased 14.2 percent in these seven tractors when new plugs were installed.



A 7.6 percent increase in horsepower resulted from air cleaner servicing.

(3) **Air cleaner** servicing was required on five of the test tractors. This resulted in a 7.6 percent increase in horsepower and a decrease in fuel consumption of 11.4 percent.



Carburetor adjustments were made on 72 percent of the tractors in the study.

(4) **Carburetor adjustments** were made on 72 percent of the tractors with 46 percent having too rich a mixture and 26 percent having too lean a mixture. Correcting the over rich fuel mixture resulted in a 9.5 percent reduction in fuel with no change in horsepower output. Correcting the lean mixture increased horsepower 2.9 percent while increasing fuel consumption 1.4.

(5) **Governor adjustments** were performed on 80 percent of the tractors checked. The no-load speed was too high on 32 percent of the tractors while full-load speed was too low on 62 percent of the tractors. The governor was judged satisfactory if it kept the engine within 20 RPM of the specified speed. Simple repairs and adjustments corrected the governor speeds on only 20 percent of the tractors. This resulted in a 9.1 percent increase in horsepower and a reduction in fuel consumption of 4.8 percent. The remaining 60 percent required replacement of worn governor parts before corrective adjustments could be made.

As pointed out earlier, the overall average result of the above adjustments and replacements was an increase in engine horsepower of 11 percent and a reduction in fuel consumption of 14.5 percent. In 1973, farmers in the United States used about 4 billion gallons of gasoline. Assuming that the nation's tractors could use 14.5 percent less fuel by keeping them better tuned, the potential national savings could be approaching 600,000,000 gallons of gasoline per year. Considering gasoline at .840 per gallon, the national savings could be $240,000,000.

FOLLOW RECOMMENDATIONS IN OWNER'S MANUAL

Review the operator's manual to determine the service intervals recommended for the particular engine on your equipment. Maintaining good service records makes it easy to plan for future service work.

Most manufacturers recommend regular tune-ups, such as spring and fall or every 300 to 1000 hours of operation. The intervals recommended for some of the tune-up procedures are based on average conditions. An operator must alter the recommended intervals to fit his conditions if they are extremely severe. For example, frequent checking of the precleaner on the air intake system in extremely dusty conditions is very important.

Farmers who do their own tune-up work might profit by going to their dealers for a tune-up every few years so their tractor could be tested on a dynamometer both before and after tuning in order to compare its performance to the original rated performance. If the "after tune-up" performance is significantly below its rating, the engine will probably need some major repairs. Knowing this in advance of a critical season would definitely aid the farmer in his planning.

This fact sheet was promulgated at a cost of $163.71, or 1.6 cents per copy, to inform farmers on how tractor tune-ups can help conserve energy.

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS
(Acts of May 8 and June 30, 1914)
Cooperative Extension Service, IFAS, University of Florida
and United States Department of Agriculture, Cooperating
K. R. Tefertiller, Director

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4-10M-77

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GASOLINE AND DIESEL ENGINES

EXAMPLE OF ENERGY SAVINGS BY FIXING A LEAKING CARBURETOR

A slowly dripping carburetor can waste .5 to 1.5 gallons of gas per day. Suppose the carburetor on one of your tractors starts leaking, and you do not find time to fix it for a month. This means at least 15 gallons of gasoline and $21.00 were wasted.

$21.00 energy savings per month

Calculations:

.5 gal/day X 30 days X $1.40 gal = $21.00

Dollars saved at various gasoline prices

Cents/gal	$1.50	1.60	2.00
Savings/month	$22.00	24.00	30.00

EXAMPLE OF ENERGY SAVINGS BY PROPER SETTING OF THERMOSTAT AND ENGINE TEMPERATURE

Be sure the thermostat is functioning properly so the engine warms up quickly, especially in winter. Fuel consumption increases by approximately 25 percent when the engine is operating at 100°F (3).

If the thermostat on your tractor is stuck open during the winter, your tractor may operate at 100°F or less no matter how long you use it. Assuming the tractor is used 40 hours during the 3 coldest months of the year, you could save $40.60 by having a properly functioning thermostat. A new thermostat cost about $3.00.

Calculations:

.7 gal/hr X 40 hr X $1.45/gal = $40.60/season
$40.60 - $3.00 = $37.60 savings per season

Engine operating Temperature °F	Gallons of Fuel Consumed per hour
100	3.5
140	3.2
160	2.9
180	2.8

Dollars saved at various diesel fuel prices

Cents/gal	$1.45
Savings/year	$37.60

EVALUATION

1. A 75 HP tractor using 5.5 gallons per hour of diesel ($1.20 gallon) and running for 400 hours would result in a total face cost of _____.

2. A 75 HP tractor used 0.5 gallon/hr of diesel ($1.20 gallon) as it idled 30 minutes a day for 365 days. Calculate the amount of fuel lost and its total cost.

3. Caluclate the difference in fuel consumption between the following tractors equipped with bias ply and radial ply tires.

   Tractor A had radial ply tires and was operated 600 hours using 5.1 gal/hr (cost $1.25 gallon).

   Tractor B had bias ply tires and was operated 640 hours using 5.5 gal/hr (cost $1.25 gallon).

4. Identify three reasons why fuel savings occur when using radial ply tires.

5. A tractor advances 90 feet with a load and 100 feet without a load. What is the percent slip?

6. Describe the tire tread pattern produced when pulling under load with the proper ballast weight, front and rear.

7. What is the general rule of thumb for determining the amount of field ballast required for mounted implements and for towed implements?

8. List three fuel tips that will reduce fuel consumption by tractors.

9. List five engine operating tips that will reduce fuel consumption by tractors.

10. List five tractor maintenance tips that will reduce fuel consumption.

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